Space Weather Technical Forecast

Issued on Thursday, 04 May 2023 at 01:33 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R3 Strong radio blackouts. Very slight chance of G1/Minor Storm conditions on 06 May. Active electron fluence continuing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity reached High levels due to a series of impulsive M-class flares, all from AR3293 (Ehi/Beta-Gamma-Delta), peaking at M7.4 at 03/1045UTC. This region in the northeast contains two small delta spots that have continuously evolved, rotating around each other and resulting in increased magnetic shear through the day. AR3296 (Dhi/Beta) in close proximity to the east of this region also developed during the period, with a consolidating area of penumbra around the leading spot and a possible small delta spot in the process of forming. Other regions of interest include AR3297 (Eki/Beta) southeast of AR3296, where there appears to be growth of the intermediate portion of the group either side of two large mature spots. AR3288 (Ehi/Beta-Gamma-Delta) in the far southwest is becoming increasingly difficult to assess, although a delta configuration is maintained and bright flux and notable magnetic looping suggest a continued potential for notable flaring. In total nine sunspots are present on the visible disc. No Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1 has slowly declined from close to 500km/s (elevated) to around 440km/s (slightly elevated) as the probable high speed stream from CH98 in the far northwest eases. Density has been around average. Total magnetic field strength was weak, below 6nT, with the north-south component, Bz, also varying weakly. Phi angle was largely negative (towards the Sun). Geomagnetic activity was Quiet throughout.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, has been at background levels throughout. High energy electron flux (greater than 2MeV) as measured at GOES16, has been at High levels, peaking at 6970 pfu at 02/1545 UTC. The 24-hour integrated fluence was at Active levels, with an increasing trend, 3.42e8 integrated pfu recorded at 04/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is expected with further M-class flares likely and a chance of isolated X-class flares occurring, mainly from the numerous complex regions in the northeast.

Solar Wind / Geomagnetic Activity: No CMEs are expected to affect Earth during the period, however, there remains a very slight chance of glancing impacts on 04 and 05 May due to the relative proximity of previously assessed CMEs. The current high speed stream, likely to be from CH98 in the northwest is expected to continue to weaken through 04 May, with winds decreasing close to, or to background levels during the next 24 hours. The next high-speed stream from CH99 is likely to connect with Earth on 06 May with speeds increasing to slightly elevated or perhaps elevated levels. A further, recurrent high-speed stream from CH01 may arrive at Earth on 07 May, although may be indistinguishable from that of CH99. Geomagnetic activity is expected to be mainly Quiet on 04 and 05 May, with a slight chance of Active intervals should any peripheral CME effects occur at Earth. Activity should become Quiet to Unsettled

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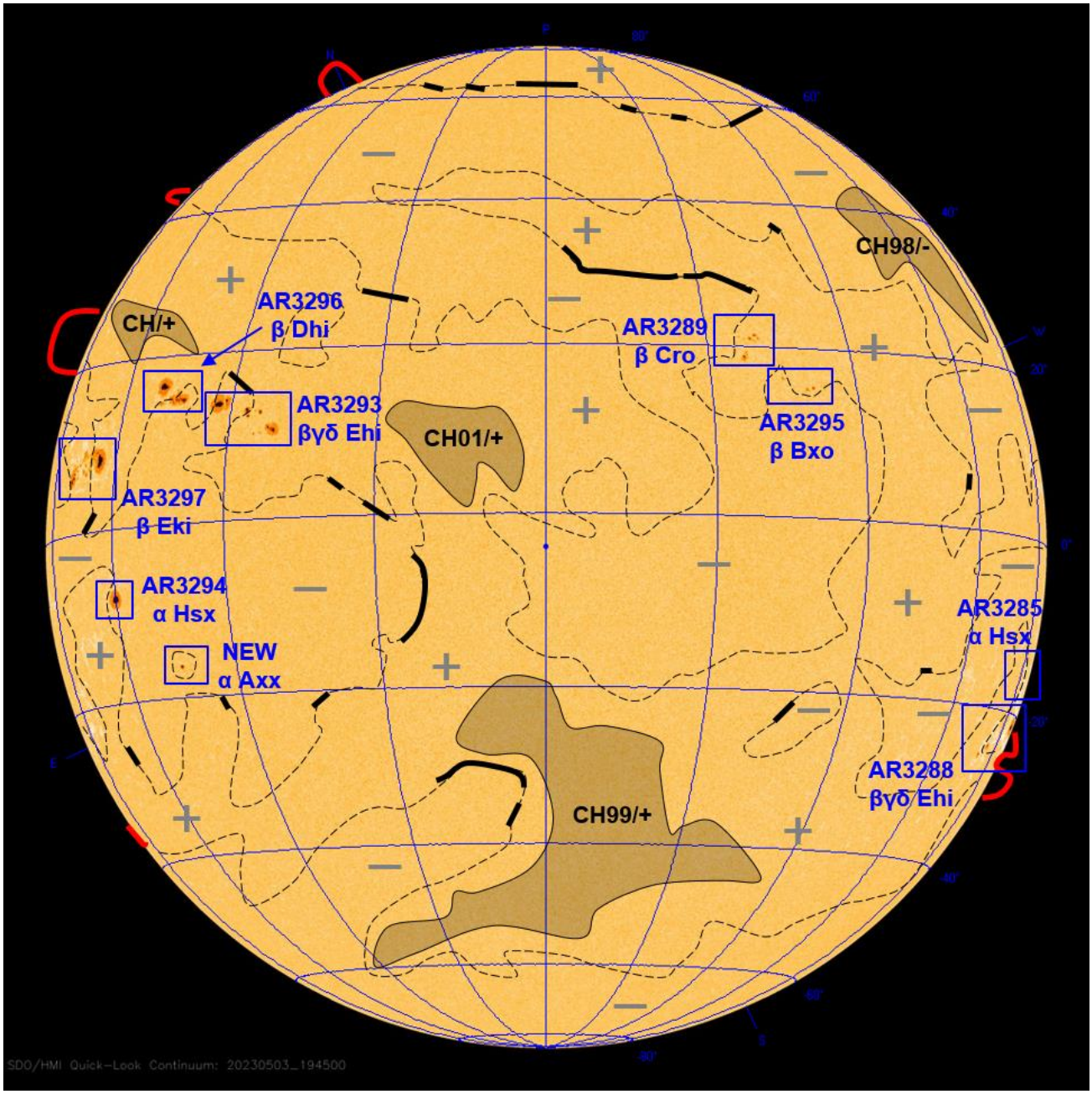
from 06 May with the onset of the high-speed stream from CH99/+ with a very slight chance of isolated G1/Minor Storm intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is most likely to persist at background with no solar radiation storms occurring. High energy (greater than 2MeV) electron flux is expected to continue a diurnal oscillation, mainly above the high threshold, but with slightly declining peaks. Brief sharp declines are possible from low probability geomagnetic activity. Electron fluence is expected to continue above the threshold, with decreasing confidence later in the period.

Figure 1. Solar Analysis Valid 03/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A number of faint filaments have erupted from the Sun in the past several days, although these have been assessed as not being Earth-directed. However, given the margin of error and relative proximity of those CMEs, especially through assessment of ensemble forecasts, there is a very slight chance of weak, glancing blows on 04 and 05 May.

The current high speed stream, likely from weak CH98/- in the northwest, continues to slowly and erratically decline. Analysis of STEREO A data, which is now less than one day ahead of the Earth, suggests that solar wind speeds could decline to around or just below 400km/s during the next 24 hours, ahead of a further high speed stream connection, most likely on 06 May from CH99/+. This fairly large feature in the south of the southern hemisphere is in the same hemisphere relative to Earth, however it is a non-recurrent feature. Therefore the strength and timing of any connection is somewhat uncertain. A peak speed of 450-500km/s is estimated. Another high-speed stream with similar speeds from CH01/+ located just above the ecliptic, near centre disc, may arrive at Earth on 07 May although may be indistinguishable from the likely pre-existing connection to CH99/+.

Geomagnetic activity is expected to be mainly Quiet on 04 and 05 May, with a slight chance of Active intervals should any peripheral CME effects occur at Earth. Activity should become Quiet to Unsettled from 06 May with the onset of the high-speed stream from CH99/+ with a very slight chance of isolated G1/Minor Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections – Nil expected.

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Radio Blackouts - X-Ray Flares:

There are currently nine sunspot regions on the visible disc. Two of these, AR3288 and AR3293 contain delta regions, with another region, AR3296 likely in the formative stages of a delta spot developing.

AR3288 in the far southwest is approaching the western limb and becoming increasingly difficult to assess, although the bright flux and magnetic looping suggest a continued potential for notable flaring. This region will rotate off the disc in the next 24 hours. AR3289 has weakened significantly in the past 24 hours with only rudimentary penumbra now visible on the leading portion of the group. The negative trailer spot has almost completely faded from view. In the northeast, AR3293 holds significant interest with the aforementioned delta spot having evolved into two smaller delta spots, these rotating around each other in close proximity within the intermediate portion of the group. To the east of AR3293 is AR3296. The region has undergone continued growth, especially within the leading negative polarity spot and consolidation of the smaller spots into a larger penumbra that appears to contain both positive and negative polarities. There is no clear umbra of opposing polarity within this area yet so a delta spot is not confirmed. It will, however, be closely monitored for any further development. The region opposes the typical polarity order expected of a northern hemispheric active region in this solar cycle, so can be classified as an 'anti-hale' sunspot group. AR3297 close to the northeast limb is rotating into clearer view and there appears to be growth in the size of penumbra within the intermediate part of the group either side of two large and mature leader and trailer spots. The remaining regions appear relatively simple with a new Axx/Alpha region having recently emerged to the southwest of AR3294. AR3285 has now reached the western horizon but could still present a flare risk from just beyond the limb.

As AR3288 and AR3285 rotate off the visible disc in the next 24 hours, new regions are expected to rotate over the eastern limb as indicated by STEREO-A EUVI imagery. This may supplement or at least maintain the existing flare risk into the coming days.

Flare probabilities have been increased in light of the developments around AR3293, AR3296 and AR3297. Further M-class flares are expected through the next four days based on current trends of development, with a chance of X-class flares, mainly from the northeast quadrant.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	20	20	20	20

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Figure 2: GOES-16/18 X-ray flux. Five M-class flares all from AR3293.

Figure 3: SDO/AIA 94 imagery at 05/0005 UTC.

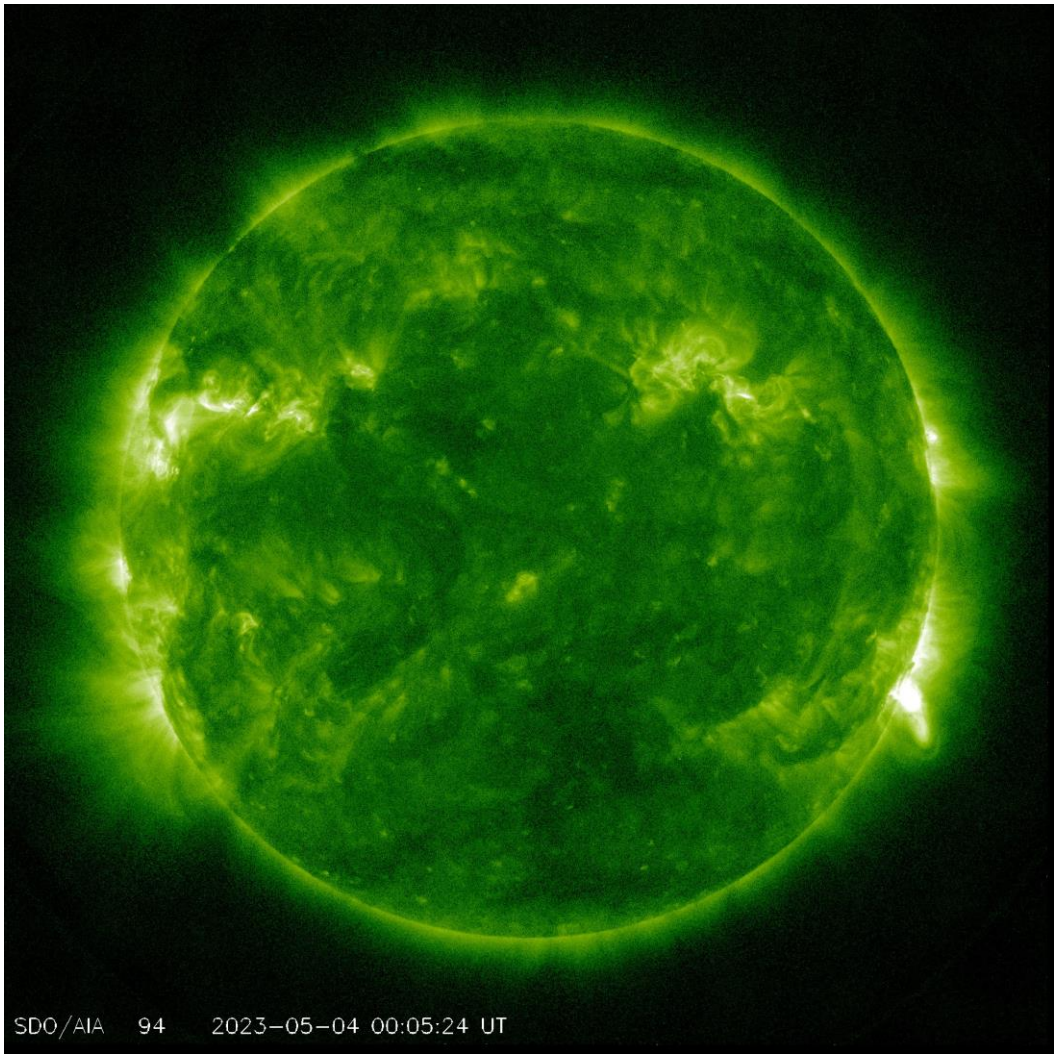

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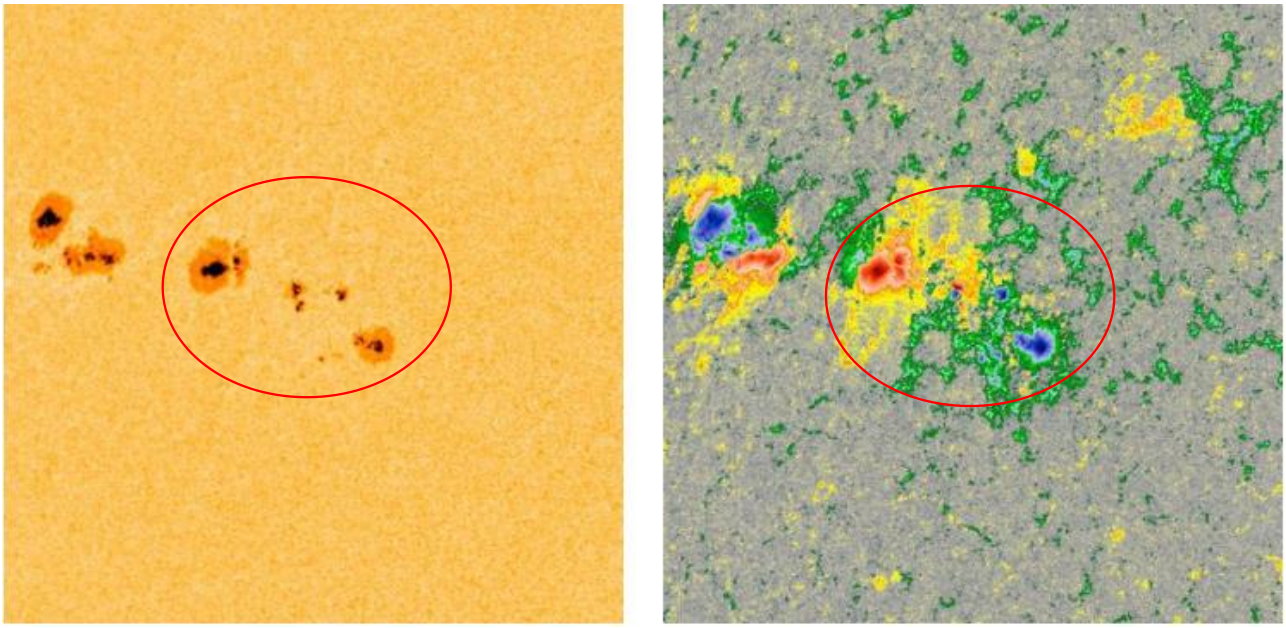
Figure 4: SDO HMI-Intensitygram and Magnetogram of AR3293 (circled) with AR3296 to the east.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux as observed by GOES-16 is forecast to remain at background levels. However, count rates may increase with any significant flares that occur, mainly from AR3288 in the far southwest with its favourable location for connection with Earth. Therefore there is a very slight chance of reaching the S1 Minor Radiation Storm threshold. As the other large and complex regions in the northeast transit the disc, the risk increases slightly at the very end of the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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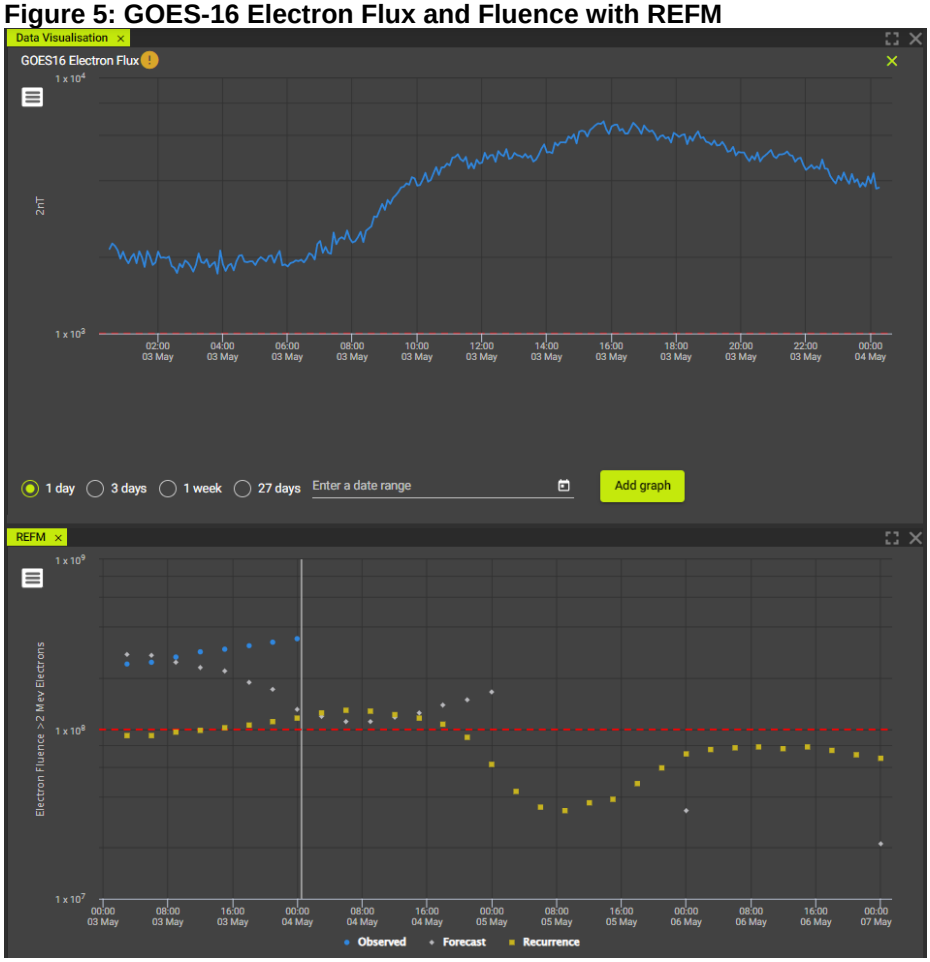
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) at GEO is expected to continue to follow an oscillating diurnal cycle above the high (1e3pfu) threshold through much of, if not all of the next four days in the absence of any significant modifying factors. The value of the peaks may fall slowly, but these peaks are still expected to exceed the high threshold. Modifying factors such as a low probability CME glance on 04 or 05 May and a possible high speed stream connection on 06 May could briefly suppress electron counts.

Electron fluence values are at Active (1e8 integrated pfu) levels and are expected to continue above this threshold for much, if not all of the period. A steady decline could occur, but this is likely to be very slow.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	80	60
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES-16 Electron Flux and Fluence with REFM



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